DISTRIBUTION OF THE ENDANGERED OTWAY STONEFLY *EUSTHENIA NOTHOFAGI* ZWICK (PLECOPTERA:EUSTHENIIDAE) IN THE OTWAY RANGES

T. DOEG & J. REED

Flora and Fauna Branch, Department of Conservation and Natural Resources, 123 Brown Street, Heidelberg, Victoria 3084

DOEG, T. & REED, J., 1995:07:31. Distribution of the Endangered Otway stonefly *Eusthenia nothofagi* Zwick (Plecoptera:Eustheniidae) in the Otway Ranges. *Proceedings of the Royal Society of Victoria* 107 (1): 45–50. ISSN 0035-9211.

A survey for the Otway stonefly *Eusthenia nothofagi* Zwick (Plecoptera:Eustheniidae) was conducted throughout the Otway Ranges, south-west Victoria. Members of the genus were located at 19 out of 52 sites sampled, widely spread through the ranges. Sites where the genus was present were located primarily in streams draining cool temperate rainforest, and wet sclerophyll forest. The main in-stream habitats where nymphs were collected were under cobbles and wood, usually restricted to slower flowing areas along the edge of stream.

Late instar nymphs were collected at 11 sites and reared through to adults. This confirmed the presence of the species *Eusthenia nothofagi* at 9 sites widely distributed throughout the Otway Ranges. No adults of *Eusthenia venosa* were reared, and it is therefore assumed that all *Eusthenia* nymphs represent records for *Eusthenia nothofagi* and that the species is widely distributed in the Otway Ranges and would probably be located within virtually all the catchments in the region, including closed catchments, reference areas and special reserves.

In our opinion, the combination of sites in areas of secure land-use, and the application of local Public Land management, is likely to provide sufficient protection to ensure the survival and future evolutionary potential of the species.

THE STONEFLY family Eustheniidae (Inseeta: Pleeoptera) is eonsidered to be of high scientific interest as it is believed to be the most arehaie and least evolved of the stoneflies. Zwick (1979) quotes Tillyard (1921) as eoncluding that 'though existing to-day, they rcprcsent the original archetypic family of the Order, from which all other types must have been derived'. The distribution of the family and sub-families is also believed to be of considerable zoogeographie interest (Campbell 1981, eited in IUCN 1983).

Following a review of the family, Zwiek (1979) erected the Otway stonefly, *Eusthenia nothofagi* Zwiek, on the basis of diffcrences in adult male genitalia from the other speeies in the genus, *E. venosa* (Tillyard). This deeision was based on adult male specimens held in the Museum of Vietoria (holotype from Beeeh Forest collected in January 1932). Adult females, from the same loeation and date, and from 1 km west of Apollo Bay (no date or eolleetor) eould not be positively assigned to either speeies as females 'seem to be similar in both speeies' (Zwick 1979, p. 37). However, without providing any definitivc reason, Zwiek stated that the two species (*E. venosa* and *E. nothofagi*) do not oeeur together. This has subsequently been taken to mean that *E. nothofagi* is restricted to the Otway Ranges, while *E. venosa* is widespread throughout the rest of Victoria.

On the basis of the presenee of only a single eonfirmed loeation, *E. nothofagi* was listed as Endangered, defined as 'taxa in danger of extinction and whose survival is unlikely if the causal factors eontinue operating' (IUCN 1983) by the International Union for Conservation of Nature and Natural Resourees, and as Endangered by Department of Conservation and Natural Resourccs (CNR 1993). The speeies was listed under the *Flora and Fauna Guarantee Act* 1988 (SAC 1991) in May 1991 as presumed extinet on the basis that it had not been positively sighted for more than 40 years.

However, in April 1991, a male adult stonefly, subsequently identified as *E. nothofagi*, was colleetcd by P. Lilywhite of the Museum of Vietoria at Melba Gully State Park, near Lavers Hill (formal eonfirmation of the identification was made after the final *Flora and Fauna Guarantee Act* listing as presumed extinet). This was the first offieial reeord of the taxon since the original specimen from whieh the speeies deseription was made.

In 1993, the Australian Nature Conservation Agency (ANCA) funded a projeet to determine the true distribution of the speeies as a preliminary aetion to the preparation of a formal Recovery Plan. This paper presents the results of the survey.

METHODS

Fifty-two sites were selected from across the Otway Ranges region (Fig. 1), primarily within the forested areas, but extending outwards into the agricultural flats surrounding the ranges. Sampling trips were conducted in March, September, October and November 1993 and in December 1994. Over this period, all sites were visited at least once (some were revisited to collect live larvae for rearing). As a long-lived species, probably spending some years in the larval phase, it is unlikely that the timing of the surveys primarily over spring and summer would have influenced the observed distribution of the species.

At each site, a total of one person-hour was spent searching in the stream for *Eusthenia* nymphs. All habitat types within the stream (primarily wood debris and stones, in backwaters and the main channel) were included. Possible habitat elements at each site were lifted and examined by eye for nymphs (this was possible due to the large size of the larvae). The number of *Eusthenia* located and the habitat in which they were found was recorded. Although not strictly quantitative, this technique provided relative abundance figures which could be compared between sites. Additionally, a further 15–30 minutes were spent inspecting the surrounding vegetation and ground for possible adult eustheniid stoneflies.

Late instar nymphs of *Eusthenia* (identified by the presence of large wingpads) were collected from 11 sites and transported live to the laboratory in plastic bags half filled with water with a pure oxygen atmosphere. Bags were placed in a cooler and covered in ice. This technique was found to result in no mortality of the nymphs during transport.

Individual nymphs were placed in net-covered cages suspended in a flow-through of aquarium water maintained at 17°C. These were checked each day and emergent adults were collected, preserved and identified.

RESULTS

Distribution

Nymphs of the genus *Eusthenia* were recorded at 19 sites (Fig. 1). These were distributed over a wide area of the Otways, from the Johanna River (at Melba Gully State Park) and Chapple Creek (a tributary of the lower Gellibrand River) in the west, to the Erskine River at Erskine Falls in the east. Sites covered almost the entire range of altitudes found in the Otway Ranges. In the majority of cases, sites were located in forested areas (cool temperate rainforest, and wet sclerophyll forest), in State Forest or National Park. Two sites (the Ford and East Barham Rivers) were in areas where agricultural clearing was relatively extensive (although the specific sites were wide streams with abundant local riparian vegetation and little obvious impact of clearing) and one (the Aire River at the Redwoods) was located primarily in pine forests. The majority of sites in State Forest had been subjected to timber harvesting activities at various intensities in the past.

Sites where larvae were not located were in incised streams where agriculture was the prevalent land-use (and where suitable slow flowing areas or habitat were absent), where some other major disturbance was obvious (e.g. downstream of the West Barwon Reservoir) and coastal streams at low altitudes (again primarily in cleared land).

No adults were located in the field during the survey.

In-stream habitat

The main habitats within the stream containing larvae were the undersides of cobbles and wood, and usually restricted to slow flowing areas within, or along the side of the stream. These cobbles or wood were generally not embedded in any deposited silt in backwaters, although some had silt deposited on their surface. However, this in-stream habitat was not exclusive, as some nymphs were located in mid-stream where the current velocity was fast.

Relative abundance

Although the number of nymphs recorded during a single person-hour search cannot be regarded as a quantitative measure of abundance (expressed in numbers per metre square of stream bed), it does allow a comparison of the numbers collected between sites.

The sites where nymphs were most abundant were at Sabine Falls (Site 37 in Fig. 1: 22 individuals), in the Johanna River at Melba Gully (Site 9: 11), West Arkins Creek (Site 3: 7), Erskine River (Site 19: 5), Carlisle River (Site 47: 4), Cumberland River (Site 39: 4) and Parker River (Site 4: 4). At the remaining sites, fewer than 4 individuals were collected.

The sites at Sabine Falls and the West Arkins Creek were the two highest sites sampled during the survey (500 m ASL), and there was a significant linear correlation between altitude and the number of nymphs collected during the standard search time (Fig. 2: $r = 0.619$, $df = 13$, $p < 0.05$).

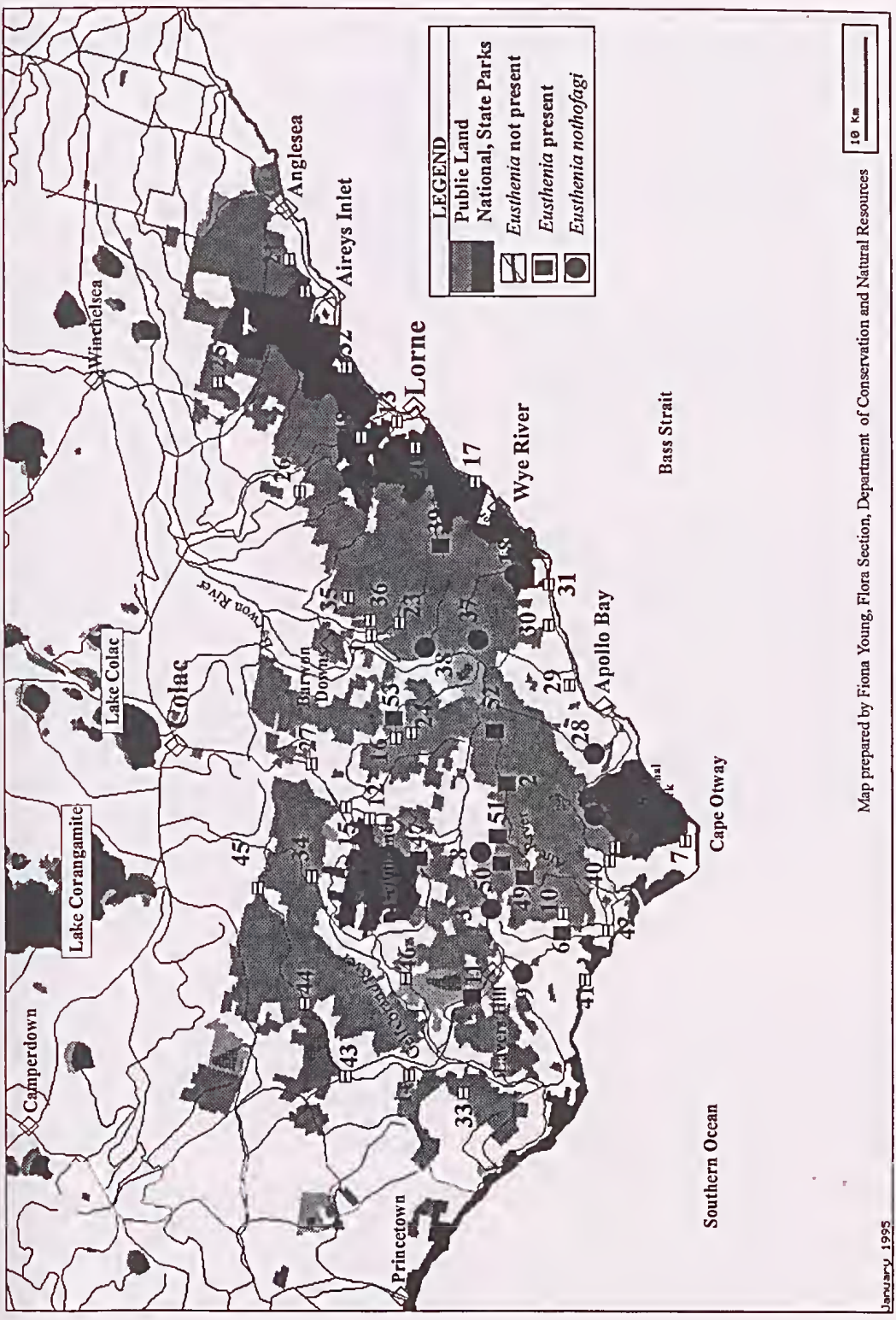

Fig. 1. Map of the Otway Ranges showing the location of sampling sites. Numbers refer to site numbers used in the survey.

Even if the Sabine Falls site (the possible outlier site in Fig. 2) is excluded from the correlation, there is still a significant positive relationship between altitude and abundance ($r = 0.565$, $df = 12$, $p < 0.05$). It would therefore appear that larger populations of the stonefly are found in higher altitude steams, although populations occur throughout the range of altitudes within the Otways (the lowest altitude where *Eusthenia* nymphs were recorded was only 40 m ASL).

Rearing trials

Twenty of the nymphs, from 11 sites, were successfully reared through to the adult stage (Table 1). Adult males were reared from 9 sites. In all cases, these were positively identified as *Eusthenia nothofagi*. Adult females were reared from 6 sites and could not be positively identified.

Site	Males	Females
Aire River (2)		1
West Arkins Creek (3)	1	1
Johanna River (9)	2	1
Young Creek (8)	1	
Grey River (18)	1	
Erskine River (19)	2	3
East Barham River (28)	1	
Trib. of Smyths Creek (37)	1	2
Parker River (4)	1	
Barwon River (38)	1	
Cumberland River (39)		1

Table 1. Number of adults that successfully emerged in the laboratory (site number from Fig. 1 in parentheses).

DISCUSSION

It is clear from the results of this survey that the Otway stonefly is spread throughout the forested areas of the Otway Ranges (at least from Melba Gully in the west, to Lorne in the east, a distance of some 50–60 km).

While there was a trend towards larger populations at higher altitudes, there is no apparent distinct trend in local conditions that would allow an estimate of likely population sizes to be made for any unsampled site. The size of streams ranged from small (< 1 m wide at Sabine Falls and the Parker River) through to relatively large (5–10 m wide at Erskine Falls and the Cumberland River). Substrata also varied somewhat between these sites, from predominantly cobbles and boulders (Erskine Falls), through cobbles and bedrock (Sabine Falls), cobbles and sand (West Arkins Creek) to mainly smaller pebbles and sand (Carlisle River) and even to a substratum composed almost entirely of compacted clay (Parker River at Maits Rest).

While the majority of these sites were in areas where the riparian vegetation formed an almost totally closed canopy, which created a dark humid streamside environment (Sabine Falls, West Arkins Creek, Parker River, Johanna River), other sites were located in more open sclerophyll forest

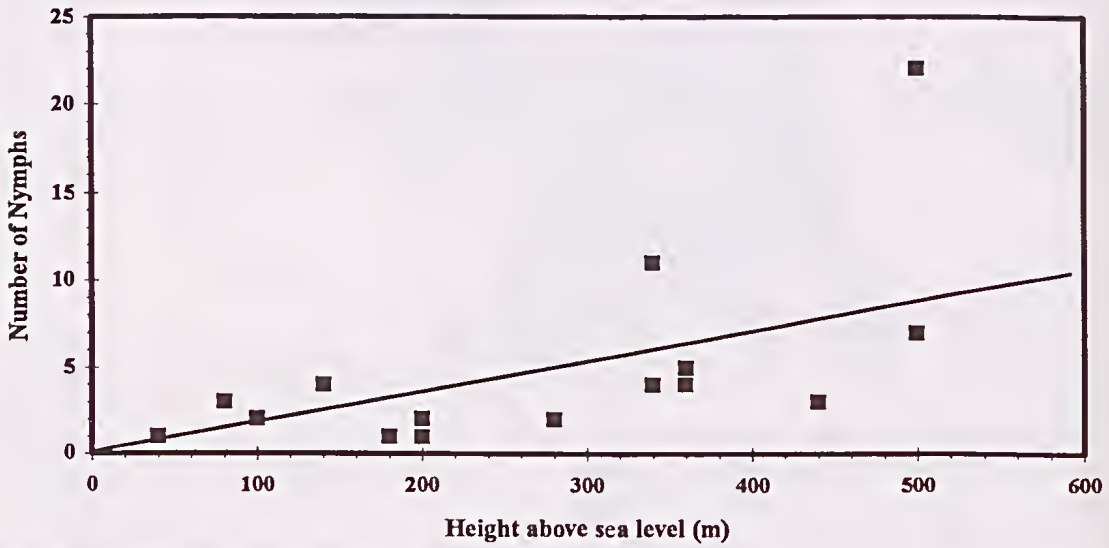

Fig. 2. Number of nymphs collected per hour plotted against the altitude of the site.

(Cumberland River, Erskine River) and in one case where the stream surface was open to the full sun (Carlisle River).

This lack of consistency between sites in their general environmental features is partly explained by the observation that nymphs were often (but not exclusively) found in slower flowing areas along the side of the stream. The presence of these backwaters is probably independent of many of the physical attributes of the stream, so that suitable microhabitat areas can be located in streams with a wide variety of macrohabitats.

Based on this survey, it is impossible to predict accurately the general conditions within a stream that would lead to high populations of the species, or the specific conditions that lead to higher populations at higher altitudes. However, the conditions where the species was located (including those that produced higher densities) are common and widespread throughout the Otways, suggesting that the species is similarly distributed.

In terms of land-use, many suitable sites within the Otway Ranges are located in National Parks or areas secure from major disturbance (e.g. closed water catchments). In the main, areas in State Forest open to timber harvesting are governed by local forestry precriptions designed to protect aquatic resources (DCE 1991).

The original belief that the Otway stonefly was endangered is a product of the lack of comprehensive surveys of the area and poor taxonomic knowledge. Poor survey coverage or taxonomic knowledge are common for freshwater macroinvertebrates and there are many examples where taxonomy is based on adult features, when the most often collected forms are larvae or nymphs. While such problems are slowly being addressed through increased survey activity (such as this study) and improved taxonomic procedures, it is likely that further work will reveal that some taxa considered rare are, in fact, common. On the other hand, improved survey and distributional knowledge will undoubtedly increase the number of taxa that will be shown to be rare or threatened (Butcher & Doeg 1995). Of the potentially thousands of aquatic macroinvertebrate species present in Victoria, only 23 are listed as rare, vulnerable or threatened in Victoria, and only 14 species are listed under the *Flora and Fauna Guarantee Act* 1988.

It is not possible to determine which of the formal conservation categories used to describe species (IUCN 1983; CNR 1993) would apply to the Otway stonefly. While demonstrably not Extinct or Endangered (as currently classified), it cannot be placed within the Vulnerable, Rare or Insufficiently Known categories (as these require demonstrable decline). Of more value would be a category like Restricted (Jackson et al. 1993), indicating a taxon that is not in apparent danger but occurs in a relatively small area.

Despite not being in immediate apparent danger, the Otway stonefly should still be seen an important species, being a living example of one of the oldest known insect orders. It can also be seen as a locally significant species, endemic to a comparatively small area of Victoria. The presence of other invertebrate species restricted to the Otway Ranges (including the Black Otway Snail *Victaphanta compacta*, the crayfish *Engaeus fultoni*, the gripopterygid stonefly *Illiesoperla austrosimplex* and the caddisfly *Taskiria otwayensis*) would seem to suggest that a number of yet undiscovered or undescribed species may well be endemic to the area. So, while locally common, *Eusthenia nothofagi* may fill the requirements for the role of a 'flagship taxon', one that can be seen as a representative for all the unique taxa present at a locale and can be utilised to highlight and raise awareness of freshwater and invertebrate issues (Yen & Butcher 1994). As such, it has a conservation significance that is not due to rarity or some formal threatened status. And with this in mind, the Otway stonefly is still worthy of conscious protection measures.

CONCLUSIONS

The Otway stonefly *Eusthenia nothofagi* Zwick is widespread throughout forested areas within the Otway Ranges. Although probably most common in small upland tributaries, the species can be located in a wide variety of stream types, in terms of stream size, bed composition and riparian condition.

ACKNOWLEDGEMENTS

This work was funded through the Endangered Species Program of the Australian Nature Conservation Agency. Valuable assistance during this survey was provided by Department of Conservation and Natural Resources staff of the South West Area, Rhonda Butcher, P. J. O'Rourke and Ruth Lennie.

REFERENCES

Butcher, R. & Doeg, T., 1995. Conservation of freshwater invertebrates. *Victorian Naturalist* 112: 15–19.

CAMPBELL, I. C., 1981. Biogeography of some rheophilous aquatic insects in the Australasian region. *Aquatic Insects* 3: 33–43.

CNR, 1993. *Threatened Fauna in Victoria*. Department of Conservation and Natural Resources, Melbourne.

DCE, 1991. *Proposed Forest Management Plan: Otway Forest Management Area*. Department of Conservation and Environment, Melbourne.

IUCN, 1983. *The IUCN Invertebrate Red Data Book*. International Union for Conservation of Nature and Natural Resources, Switzerland.

JACKSON, P. D., KOEHN, J. D. & WAGER, R., 1993. Australia's threatened fishes 1992 listing—Australian Society for Fish Biology. In *Sustainable Fisheries through Sustaining Fish Habitat*, D. A. Hancock, ed., Australian Government Printing Service, Canberra.

SAC, 1991. Scientific Advisory Committee, Flora and Fauna Guarantee: Final recomendation on a Nomination for Listing: *Eusthenia nothofagi*. Department of Conservation and Environment, Victoria.

TILLYARD, R. J., 1921. Revision of the family Eustheniidae (Order Perlaria) with descriptions of new genera and species. *Proceedings of the Linnaean Society of New South Wales* 46: 221–236.

YEN, A. & BUTCHER, R., 1994. *An Overview of the Conservation Status of Non-Marine Invertebrates in Australia*. Endangered Species Unit and Australian Nature Conservation Agency, Canberra.

ZWICK, P., 1979. Revision of the stonefly family Eustheniidae (Plecoptera), with emphasis on the fauna of the Australian region. *Aquatic Insects* 1: 17–50.